

AN OVERVIEW OF THE AMPHIBIAN FAUNA OF INDIA

ROBERT F. INGER¹ AND SUSHIL K. DUTTA²

INTRODUCTION

The last complete review of the Amphibia of India was Boulenger's in 1890. Since then many papers have been published describing new species (e.g., Rao 1937), revising certain species groups (e.g., Pillai 1978), or reviewing the species of a particular area (e.g., Daniel 1963, 1975). Through these publications and others cited below, the number of species of amphibians known to occur in India has more than doubled the 77 reported by Boulenger. Additions to the known fauna have not ended. The literature of the last 100 years has also added much to our knowledge of the distribution of Indian amphibians (e.g., Mahendra 1939, Jayaram 1974). Yet even a casual examination of Tables 1 and 2 in this paper will reveal that in this area, too, there is much to learn.

Given that so many basic facts concerning composition and distribution of the fauna remain to be gathered, we present this overview knowing that it will require serious revision in the future. Nonetheless, we believe its publication now is justified if for no other reason than to provide a summary of present knowledge. The relationship of the Indian fauna to those of adjacent areas can also be discerned now, even given the imperfect state of our knowledge. We present our view of that

relationship. We are indebted to Mr. J. C. Daniel, who suggested that we consider this review.

SIZE AND COMPOSITION OF THE INDIAN AMPHIBIAN FAUNA

The variety of climates, vegetation, and topography encompassed by India (including here Sikkim and Bhutan) provide a great range of environments which leads one to expect a highly diverse fauna. The Amphibia reflect this effect, for at least 181 species occur in India (Table 1). Yet, as we will show below, there are good reasons for believing that the Indian amphibian fauna is still incompletely known and that the true diversity of the fauna is greater than just indicated.

All three extant orders of Amphibia occur in India: Caudata (salamanders) — 1 species; Gymnophiona (caecilians) — 15 species; Anura (frogs and toads) — 165 species. That only one species of salamander is found in India is not surprising, for the group is essentially temperate in its Asian distribution. Only three species occur south of China in eastern Asia, none south of the southern flank of the Himalayas and northern Burma, Thailand, and Vietnam. The caecilians, a small pan-tropical group with only about 160 species world-wide, had been little studied anywhere in the world until recently. Seven of the Indian species were described in 1960-1964 (Taylor 1960, 1964).

Frogs and toads make up 91% of species of Indian amphibians, which is just slightly

¹ Field Museum of Natural History, Chicago, Illinois, USA.

² Utkal University, Vani Vihar, Bhubaneswar, Orissa, India.

TABLE 1

LIST OF INDIAN SPECIES OF AMPHIBIANS AND KNOWN OCCURRENCE IN STATES

Species	States
ANURA	
PELOBATIDAE:	
1 <i>Leptobrachium hasselti</i> Tschudi, 1838	Meghalaya
2 <i>Megophrys boettgeri</i> (Boulenger, 1899)	Assam, Arunachal Pradesh
3 <i>Megophrys parva</i> (Boulenger, 1893)	Sikkim, West Bengal
4 <i>Megophrys robusta</i> (Boulenger, 1908)	West Bengal
5 <i>Scutiger occidentalis</i> Dubois, 1977	Jammu & Kashmir
6 <i>Scutiger sikkimensis</i> (Blyth, 1854)	Sikkim, West Bengal
BUFONIDAE:	
7 <i>Ansonia ornata</i> Günther, 1875	Karnataka
8 <i>Ansonia rubigina</i> Pillai & Pattabiraman, 1981	Kerala
9 <i>Bufo abatus</i> Ahl, 1925	West Bengal
10 <i>Bufo beddomii</i> Günther, 1875	Kerala
11 <i>Bufo brevirostris</i> Rao, 1937	Karnataka
12 <i>Bufo camortensis</i> Mansukhani & Sarkar, 1980	Andaman Islands
13 <i>Bufo fergusonii</i> Boulenger, 1892	Andhra Pradesh, Karnataka, Kerala, Orissa, Tamil Nadu
14 <i>Bufo himalayana</i> Günther, 1894	Arunachal Pradesh, Meghalaya, Sikkim, West Bengal
15 <i>Bufo hololius</i> Günther, 1875	Kerala
16 <i>Bufo koynayensis</i> Soman, 1963	Maharashtra
17 <i>Bufo latastii</i> Boulenger, 1882	Jammu & Kashmir
18 <i>Bufo melanostictus</i> Schneider, 1799	all
19 <i>Bufo microtypanum</i> Boulenger, 1882	Kerala
20 <i>Bufo parietalis</i> Boulenger, 1882	Kerala
21 <i>Bufo silentvalleyensis</i> Pillai, 1981	Kerala
22 <i>Bufo stomaticus</i> Lutken, 1862	Assam, Bihar, Himachal Pradesh, Karnataka, Jammu & Kashmir, Maharashtra, Orissa, West Bengal
23 <i>Bufo stuarti</i> Smith, 1929	Assam
24 <i>Bufo viridis</i> Laurenti, 1768	Jammu & Kashmir, Punjab
25 <i>Bufoides meghalayana</i> (Yazdani & Chanda, 1971)	Meghalaya
26 <i>Pedostibes kempfi</i> (Boulenger, 1919)	Meghalaya
27 <i>Pedostibes tuberculosus</i> Günther, 1875	Kerala
HYLIDAE:	
28 <i>Hyla annectans</i> Jerdon, 1870	Assam, Meghalaya
MICROHYLIDAE:	
29 <i>Ka'oula pulchra</i> Gray, 1831	Assam, Karnataka, West Bengal
30 <i>Melanobatrachus indicus</i> Beddome, 1878	Kerala
31 <i>Microhyla berdmorei</i> (Blyth, 1856)	Meghalaya
32 <i>Microhyla chakrapani</i> Pillai, 1977	Andamans
33 <i>Microhyla inornata</i> Boulenger, 1890	Andamans
34 <i>Microhyla ornata</i> (Duméril & Bibron, 1841)	all
35 <i>Microhyla rubra</i> (Jerdon, 1854)	Assam, Kerala, Tamil Nadu, West Bengal
36 <i>Ramanella anamalaiensis</i> Rao, 1937	Kerala

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TABLE 1 (contd.)

37	<i>Ramanella minor</i> Rao, 1937	Karnataka
38	<i>Ramanella montana</i> (Jerdon, 1854)	Kerala, Maharashtra
39	<i>Ramanella marmorata</i> Rao, 1937	Karnataka
40	<i>Ramanella triangu'laris</i> (Günther, 1875)	Karnataka, Kerala, Tamil Nadu
41	<i>Ramanella variegata</i> (Stoliczka, 1872)	Karnataka, Kerala, Madhya Pradesh, Orissa, Tamil Nadu, West Bengal
42	<i>Uperodon globulosus</i> (Günther, 1864)	Assam, Bihar, Karnataka, Madhya Pradesh, Maharashtra, Orissa, West Bengal
43	<i>Uperodon systoma</i> (Schneider, 1799)	Karnataka, Kerala, Orissa, Himachal Pradesh, Tamil Nadu, Uttar Pradesh, West Bengal
RANIDAE:		
44	<i>Amolops afghanus</i> (Günther, 1858)	Arunachal Pradesh, Himachal Pradesh, Meghalaya, Sikkim, West Bengal
45	<i>Amolops formosus</i> (Günther, 1875)	Meghalaya, Punjab, Sikkim, West Bengal
46	<i>Amolops monticola</i> (Anderson, 1871)	West Bengal
47	<i>Micrixalus borealis</i> Annandale, 1912	Arunachal Pradesh
48	<i>Micrixalus fuscus</i> (Boulenger, 1882)	Kerala
49	<i>Micrixalus nudis</i> Pillai, 1978	Kerala
50	<i>Micrixalus opisthorhodus</i> (Günther, 1868)	Kerala
51	<i>Micrixalus saxicolus</i> (Jerdon, 1853)	Kerala
52	<i>Micrixalus silvaticus</i> (Boulenger, 1882)	Kerala, Tamil Nadu
53	<i>Micrixalus thampii</i> Pillai, 1981	Kerala
54	<i>Nannobatrachus beddomii</i> Boulenger, 1882	Kerala, Tamil Nadu
55	<i>Nannobatrachus kempholeyensis</i> Rao, 1937	Karnataka
56	<i>Nanorana pleskei</i> Günther, 1896	Jammu & Kashmir
57	<i>Nyctibatrachus aliciae</i> Inger, Shaffer, Koshy & Bakde 1984	Kerala
58	<i>Nyctibatrachus deccanensis</i> Dubois, 1984	Kerala
59	<i>Nyctibatrachus humayuni</i> Bhaduri & Kripalani, 1955	Maharashtra
60	<i>Nyctibatrachus major</i> Boulenger, 1882	Kerala
61	<i>Nyctibatrachus minor</i> Inger, Shaffer, Koshy, & Bakde, 1984	Kerala
62	<i>Nyctibatrachus sanctipalustris</i> Rao, 1920	Karnataka
63	<i>Nyctibatrachus sylvaticus</i> Rao, 1937	Karnataka
64	<i>Occidozyga lima</i> Kuhl & Van Hasselt, 1822	West Bengal
65	<i>Rana alticola</i> Boulenger, 1882	Meghalaya, Sikkim
66	<i>Rana andamanensis</i> Stoliczka, 1870	Andamans
67	<i>Rana annandalii</i> Boulenger, 1920	West Bengal
68	<i>Rana assamensis</i> Sclater, 1892	Meghalaya, West Bengal
69	<i>Rana aurantiaca</i> Boulenger, 1904	Karnataka, Kerala
70	<i>Rana beddomii</i> (Günther, 1875)	Kerala, Maharashtra
71	<i>Rana bilineata</i> Pillai & Chanda, 1981	Meghalaya
72	<i>Rana blanfordii</i> Boulenger, 1882	Meghalaya, Uttar Pradesh, West Bengal
73	<i>Rana brachytarsus</i> (Günther, 1875)	Kerala
74	<i>Rana brevipalmata</i> Peters, 1871	Kerala, Tamil Nadu
75	<i>Rana cancrivora</i> Gravenhorst, 1829	Madhya Pradesh
76	<i>Rana crassa</i> Jerdon, 1853	Andhra Pradesh, Bihar, Kerala, Orissa, Tamil Nadu, Uttar Pradesh, West Bengal,

TABLE 1 (contd.)

77	<i>Rana curtipes</i> Jerdon, 1853	Karnataka, Kerala
78	<i>Rana cyanophlyctis</i> Schneider, 1799	all
79	<i>Rana danieli</i> Pillai & Chanda, 1977	Meghalaya
80	<i>Rana diplosticta</i> (Günther, 1875)	Kerala
81	<i>Rana doriae</i> Boulenger, 1887	Andamans
82	<i>Rana garoensis</i> Boulenger, 1920	Meghalaya
83	<i>Rana gerbillus</i> Annandale, 1912	Arunachal Pradesh, Meghalaya
84	<i>Rana hascheana</i> (Stoliczka, 1870)	Andamans
85	<i>Rana hexadactyla</i> Lesson, 1834	Andhra Pradesh, Gujarat, Karnataka, Kerala, Maharashtra, Orissa, Rajasthan (?), Tamil Nadu, West Bengal
86	<i>Rana intermedius</i> Rao, 1937	Karnataka
87	<i>Rana keralensis</i> Dubois, 1980	Kerala
88	<i>Rana khasiana</i> (Anderson, 1871)	Meghalaya
89	<i>Rana laticeps</i> Boulenger, 1882	Assam
90	<i>Rana leithii</i> Boulenger, 1888	Gujarat, Kerala, Madhya Pradesh, Maharashtra
91	<i>Rana leptodactyla</i> Boulenger, 1882	Kerala
92	<i>Rana leptoglossa</i> (Cope, 1868)	Assam, Meghalaya
93	<i>Rana liebigii</i> Günther, 1860	Jammu & Kashmir, Sikkim, Uttar Pradesh, West Bengal
94	<i>Rana limnocharis</i> Boie, 1835	all
95	<i>Rana livida</i> (Blyth, 1855)	Assam, Meghalaya, Sikkim, West Bengal
96	<i>Rana malabarica</i> Tschudi, 1838	Kerala, Madhya Pradesh, Maharashtra
97	<i>Rana mawphlangensis</i> Pillai & Chanda, 1977	Manipur, Meghalaya
98	<i>Rana minica</i> Dubois, 1975	Himachal Pradesh, Uttar Pradesh
99	<i>Rana murthii</i> Pillai, 1979	Kerala
100	<i>Rana nicobariensis</i> (Stoliczka, 1870)	Nicobars
101	<i>Rana nilagirica</i> Jerdon, 1853	Kerala, Tamil Nadu
102	<i>Rana phrynoderma</i> Boulenger, 1882	Kerala
103	<i>Rana sauriceps</i> Rao, 1937	Karnataka
104	<i>Rana semipalmata</i> Boulenger, 1882	Kerala
105	<i>Rana sikimensis</i> Jerdon, 1870	Meghalaya, Sikkim, West Bengal
106	<i>Rana sternosignata</i> Murray, 1885	Jammu & Kashmir
107	<i>Rana syhadrensis</i> Annandale, 1919	Maharashtra, Orissa
108	<i>Rana taipehensis</i> Van Denburgh, 1909	Assam, Orissa, West Bengal
109	<i>Rana temporalis</i> (Günther, 1864)	Karnataka, Kerala, Maharashtra
110	<i>Rana tenuilingua</i> Rao, 1937	Karnataka
111	<i>Rana tigerina</i> Daudin, 1803	all
112	<i>Rana travancorica</i> Annandale, 1910	Kerala
113	<i>Rana tuberculata</i> Tilak & Roy, 1985	Uttar Pradesh
114	<i>Rana vicina</i> Stoliczka, 1872	Himachal Pradesh, Jammu & Kashmir, Punjab, Uttar Pradesh
115	<i>Ranaxalus gundia</i> Dubois, 1985	Karnataka
116	<i>Tomopterna breviceps</i> (Schneider, 1799)	Bihar, Himachal Pradesh, Kerala, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal
117	<i>Tomopterna dobsonii</i> (Boulenger, 1882)	Andhra Pradesh, Karnataka, Tamil Nadu
118	<i>Tomopterna leucorhynchus</i> (Rao, 1937)	Karnataka
119	<i>Tomopterna parambikulamana</i> (Rao, 1937)	Kerala
120	<i>Tomopterna rolandae</i> Dubois, 1983	Kerala, Madhya Pradesh, Orissa, Tamil Nadu, West Bengal

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TABLE 1 (contd.)

121	<i>Tomopterna rufescens</i> (Jerdon, 1854)	Kerala, Maharashtra
RHACOPHORIDAE:		
122	<i>Chirixalus doriae</i> Boulenger, 1893	Arunachal Pradesh
123	<i>Philautus andersoni</i> (Ahl, 1927)	Assam
124	<i>Philautus annandalii</i> (Boulenger, 1906)	Assam, West Bengal
125	<i>Philautus beddomii</i> (Günther, 1875)	Kerala
126	<i>Philautus bombayensis</i> (Annandale, 1919)	Maharashtra
127	<i>Philautus chalazodes</i> (Günther, 1865)	Kerala
128	<i>Philautus charius</i> Rao, 1937	Karnataka, Kerala
129	<i>Philautus cherrapunjiae</i> Roonwal & Kripalani, 1961	Meghalaya
130	<i>Philautus crnri</i> Dutta, 1985	Karnataka
131	<i>Philautus elegans</i> Rao, 1937	Karnataka
132	<i>Philautus femoralis</i> (Günther, 1864)	Kerala
133	<i>Philautus flaviventris</i> (Boulenger, 1882)	Kerala
134	<i>Philautus garo</i> (Boulenger, 1919)	Meghalaya
135	<i>Philautus glandulosus</i> (Jerdon, 1853)	Kerala, Maharashtra
136	<i>Philautus hassanensis</i> Dutta, 1985	Karnataka
137	<i>Philautus kempiae</i> (Boulenger, 1919)	Meghalaya
138	<i>Philautus kottigeharensis</i> Rao, 1937	Karnataka
139	<i>Philautus leucorhinus</i> (Lichtenstein & Martens, 1856)	Kerala
140	<i>Philautus melanensis</i> Rao, 1937	Karnataka
141	<i>Philautus narainensis</i> Rao, 1937	Karnataka
142	<i>Philautus noblei</i> (Ahl, 1927)	Kerala
143	<i>Philautus parkeri</i> (Ahl, 1927)	Kerala
144	<i>Philautus pulcherrimus</i> (Ahl, 1927)	Kerala
145	<i>Philautus shillongensis</i> Pillai & Chanda, 1973	Meghalaya
146	<i>Philautus signatus</i> (Boulenger, 1882)	Kerala
147	<i>Philautus swamianus</i> Rao, 1937	Karnataka
148	<i>Philautus temporalis</i> (Günther, 1864)	Kerala
149	<i>Philautus travancoricus</i> (Boulenger, 1891)	Kerala
150	<i>Philautus variabilis</i> (Günther, 1858)	Andhra Pradesh, Kerala
151	<i>Polypedates leucomystax</i> (Gravenhorst, 1829)	Arunachal Pradesh, Assam, Sikkim, West Bengal
152	<i>Polypedates maculatus</i> (Gray, 1834)	all (except Haryana, Punjab, Rajasthan)
153	<i>Rhacophorus bipunctatus</i> Ahl, 1927	Arunachal Pradesh, Meghalaya
154	<i>Rhacophorus calcadensis</i> Ahl, 1927	Kerala
155	<i>Rhacophorus dubius</i> Boulenger, 1882	West Bengal
156	<i>Rhacophorus jerdonii</i> (Günther, 1875)	Arunachal Pradesh, Assam, West Bengal
157	<i>Rhacophorus lateralis</i> Boulenger, 1883	Kerala
158	<i>Rhacophorus malabaricus</i> Jerdon, 1870	Karnataka, Kerala
159	<i>Rhacophorus maximus</i> Günther, 1858	Arunachal Pradesh, Meghalaya, West Bengal
160	<i>Rhacophorus naso</i> Annandale, 1912	Arunachal Pradesh
161	<i>Rhacophorus pleurostictus</i> (Günther, 1864)	Kerala, Tamil Nadu
162	<i>Rhacophorus taeniatus</i> Boulenger, 1906	West Bengal
163	<i>Rhacophorus tuberculatus</i> (Anderson, 1871)	Assam, West Bengal
164	<i>Theلودerma asper</i> (Boulenger, 1886)	Arunachal Pradesh
165	<i>Theلودerma moloch</i> (Annandale, 1912)	Arunachal Pradesh

TABLE 1 (contd.)

GYMNOPHIONA

ICHTHYOPHIIIDAE:

166	<i>Ichthyophis beddomei</i> Peters, 1879	Karnataka, Kerala, Tamil Nadu
167	<i>Ichthyophis bombayensis</i> Taylor, 1960	Maharashtra
168	<i>Ichthyophis malabarensis</i> Taylor, 1960	Kerala
169	<i>Ichthyophis pen'sularis</i> Taylor, 1960	Kerala, Tamil Nadu
170	<i>Ichthyophis sikkimensis</i> Taylor, 1960	Sikkim, West Bengal
171	<i>Ichthyophis subterrestris</i> Taylor, 1960	Kerala, Maharashtra
172	<i>Ichthyophis tricolor</i> Annandale, 1909	Kerala
173	<i>Uraeotyphlus malabaricus</i> (Beddome, 1870)	Kerala
174	<i>Uraeotyphlus menoni</i> Annandale, 1913	Kerala
175	<i>Uraeotyphlus narayani</i> Seshachar, 1939	Kerala
176	<i>Uraeotyphlus oxyurus</i> (Duméril & Bibron, 1841)	Kerala

CAECILIIDAE:

177	<i>Gegeneophis carnosus</i> (Beddome, 1870)	Kerala
178	<i>Gegeneophis fulleri</i> (Alcock, 1904)	Assam
179	<i>Gegeneophis ramaswamii</i> Taylor, 1964	Kerala
180	<i>Indotyphlus battersbyi</i> Taylor, 1960	Maharashtra

CAUDATA

SALAMANDRIDAE:

181	<i>Tylostotriton verrucosus</i> Anderson, 1871	Arunachal Pradesh, Sikkim, West Bengal
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more than their percentage on a world-wide basis. Twenty of the species of anurans have been described since 1970. Wherever recent intensive collecting has been carried out in India, new species of frogs and toads have been discovered, for example, at Silent Valley (Pillai 1981, Pillai and Pattabiraman 1981) and Ponmudi (Inger *et al.* 1984) in Kerala and in Meghalaya (Pillai and Chanda 1973, 1978; Yazdani and Chanda 1971). Chanda has three new species from northeastern India in manuscript (Chanda, personal communication); these are not included in our count of species, but they emphasize the point being made here. As none of these new species can be called "cryptic" or "sibling" and as only one of them belongs to a taxonomically difficult genus (*Philautus* in this case), the accretion of new forms to the faunal list is still the result of relatively coarse screening. It seems clear that further collecting, particularly in the Eastern and Western Ghats, should uncover additional new species, and that more intensive work in

the Northeast should result in new Indian records of species now known only from the hilly country of Southeast Asia. Recent discovery of sibling species in such widely distributed "species" as *Rana limnocharis* (Dubois 1975) and the virtual doubling of the number of species of caecilians in the last 25 years are additional indications that one can expect the faunal list to grow significantly.

The faunal list includes eight genera not found outside India: among the caecilians, *Indotyphlus*, *Gegeneophis*, and *Uraeotyphlus*; among the anurans, the bufonid *Bufoides*, the microhylid *Melanobatrachus*, and the ranids *Ranaxalus*, *Nannobatrachus* and *Nyctibatrachus*. The last two are closely related (Shaffer, in press) and, together with *Nannophrys* from Sri Lanka, probably constitute a single, distinctively Indian, ranid radiation. In addition to *Melanobatrachus*, the microhylid genera *Ramanella* (with 6 species in India and 2 in Sri Lanka) and *Uperodon* (with one of its two species occurring in Sri Lanka as well as

in India) represent at least one additional Indian radiation; the uncertainty arises because, despite an excellent monograph on the Microhylidae (Parker 1934), phylogenetic relationships within the family are obscure. The ranid genus *Micrixalus* has most of its species in India. Indeed, Pillai (1978) has suggested that only the species from India and Sri Lanka are congeneric. At the very least, the Indian species of *Micrixalus* constitute another regional radiation. The recently described *Ranixalus* appears to us, on the basis of the original diagnosis and description (Dubois 1985), to be closely related to *Micrixalus* and part of the same radiation. The caecilian genera are members of two families and, therefore, represent at least two more Indian radiations.

Additional evidence for the distinctiveness of the Indian amphibian fauna comes from the four most speciose anuran genera, *Bufo*, *Rana*, *Philautus*, and *Rhacophorus*, and the largest caecilian genus, *Ichthyophis*, all of which have wide distributions outside of India. Species of these four anuran genera account for 106 of the 165 species of frogs and toads occurring in India, and of those 106, 61 are restricted to India. If we add in those species whose ranges do not extend beyond the territories immediately adjacent to India, i.e., Sri Lanka, Pakistan, Nepal, and Bangladesh, endemism in these four anuran genera increases to 77%. All seven of the Indian species of *Ichthyophis* are restricted to the territory of India. Turning the picture around, we find only 23% of 181 species of Indian amphibians occur beyond the fringes of India as far as China, Burma, or Southwestern Asia.

GEOGRAPHIC DISTRIBUTION WITHIN INDIA

The abundance of species of amphibians is very uneven across India. The highest con-

centrations of species and genera are in the Northeast and in the Western Ghats of the West Peninsular region (Table 2). As endemic species constitute 62% of the Indian fauna, it is not surprising that the distribution of endemics is also uneven: 84 of the endemics are found only in the Western Ghats and 20 only in the Northeast region. The magnitude of the disparity between the two areas of highest diversity and the others shown in the table is partly a reflection of very unequal collecting intensity. This effect seems especially apparent in the case of the Eastern Ghats (included in the East Peninsular region of Table 2); the semi-deciduous forests that still exist there in patches should provide good habitats for a number of species. Yet no endemic arboreal anuran has been recorded from the ghats in Orissa or Andhra Pradesh. However, given the long known association between amphibian diversity and perhumid environments (for an Asian example, see Inger 1980) we expect the regional disparity shown in the table to remain large, for the Northeast and the Western Ghats are the areas of heaviest precipitation in India. The high diversity regions are also those that until relatively recently had large areas of tropical evergreen forests, structurally complex environments providing the maximum number of microhabitats. The interaction between forest environments and diversity is clearly seen when the proportions of bush and tree dwelling frogs in the fauna of the Northeast (32%) and Western Ghats (29%) are compared to the proportions (<13%) in the other regions.

A small group of anuran species accounts for much of the overlap between regions: *Bufo melanostictus*, *Microhyla ornata*, *Rana cyanophlyctis*, *R. limnocharis*, *R. tigerina*, and *Polypedates maculatus*. These species live in close association with man wherever they occur

TABLE 2

DISTRIBUTION OF INDIAN AMPHIBIANS BY REGIONS. THE CLIMATES OF THE INDIAN REGIONS AS DEFINED HERE ARE: NORTHWEST—TEMPERATE, MONTANE; WEST—ARID TO SEMIARID; DECCAN—HOT, MONSOONAL; GANGES-BRAHMAPUTRA VALLEY—HUMID, HOT, MONSOONAL; EAST PENINSULAR—MONSOONAL, HUMID IN AREAS; NORTHEAST—HUMID, TO SUBTROPICAL TO TROPICAL, MONTANE; WEST PENINSULAR—HUMID TROPICAL, PARTLY MONTANE.

Region	States included	Order	Genera	Species	Species code*
Northwest	Jammu & Kashmir	Anura	9	21	5, 17-8, 22, 24, 34,
	Himachal Pradesh				43-5, 56, 72, 78, 93-4,
	Punjab				98, 106, 111, 113-4,
	Uttar Pradesh (part)				116, 152
West	Gujarat	Anura	5	9	18, 34, 78, 85, 90,
	Rajasthan				94, 111, 116, 152
Deccan	Madhya Pradesh	Anura	7	18	13, 18, 22, 41-2, 75,
	Andhra Pradesh (part)				76, 78, 85, 90, 94,
	Bihar (part)				96, 111, 116-7, 120,
	Karnataka (part)				150, 152
	Maharashtra (part)				
Ganges-Brahmaputra Valley	Tamil Nadu (part)	Anura	9	18	18, 22, 29, 34-5,
	Uttar Pradesh (part)				41-3, 64, 76, 78, 85,
	Bihar (part)				94, 108, 111, 116,
	Assam (part)				120, 152
East Peninsular	West Bengal (part)	Anura	8	21	13, 18, 22, 34-5,
	Orissa				41-3, 76, 78, 85, 94,
	Andhra Pradesh (part)				101, 107-8, 111, 116,
Northeast	Tamil Nadu (part)	Anura	16	53	117, 120, 150, 161
	Arunachal Pradesh				1-4, 6, 9, 14, 18, 23,
	Bhutan				25-6, 28, 31, 34, 44-7,
	Manipur				65, 67-8, 71-2, 78-9,
	Meghalaya				82-3, 88-9, 92-5, 97,
	Sikkim				105, 111, 122-4, 129,
	Assam (part)				134, 137, 145, 151,
West Bengal (part)	153, 155-6, 159-60,				
West Peninsular		Gymnophiona	2	2	170, 178
		Caudata	1	1	181
	Kerala	Anura	17	99	7-8, 10-1, 13, 15-6,
	Maharashtra (part)				18-22, 27, 29-30,
	Karnataka (part)				34-43, 48-55, 57-63,
	Tamil Nadu (part)				69, 70, 73-4, 76-8,
					80, 85-7, 90-1, 94,
					96, 99, 101-4, 107,
					109-12, 115-21,
					125-8, 130-3, 135-6,
	138-44, 146-50, 152,				
	154, 157-8, 161				
	Gymnophiona	4	13	166-9, 171-7, 179-80	

* Species code = numbers preceding species names in Table 1.

and all but the last range far beyond the borders of India. Removal of these ubiquitous commensals of mankind from the regional lists eliminates or greatly reduces overlap among regions. In fact, without these six weed-like species, there remain only five significant overlaps (i.e., 7 or more species in common to two regions) among regional faunas: both Deccan and Ganges-Brahmaputra faunas with the East and West Peninsular faunas and between the East and West Peninsular faunas. The known overlaps among regional faunas, with the six commensals of man removed, are accounted for largely by a set of seven other species that burrow and live in open fields: *Bufo stomaticus*, *Uperodon globulosus*, *U. systoma*, *Rana crassa*, *Tomopterna breviceps*, *T. dobsoni*, and *T. rolandae*. The only exceptional overlap is that between Northeast and Northwest faunas, which involves four swift-water breeders typical of mountainous areas: *Rana blanfordi*, *R. liebigei*, and two species of *Amolops*. Thus, virtually all of the similarity among regions, considering all species of amphibians, is accounted for by species of anurans that can tolerate conditions created by man's activities.

The most distinctive regional faunas are the two largest, the Northeast and the West Peninsular. Pillai and Chanda (1976) recorded the species known at the time from the Northeast and Chanda has a thorough review of this fauna in ms. As would be expected, in the Northeast one finds the largest concentration of species whose ranges are mainly Southeast Asian or Burman-Chinese, 28 of 56 species. In the West Peninsular, as already noted, the largest number of endemics occurs. All Indian caecilians are confined to these two areas of high diversity, 2 of the genera and 13 of 15 species being restricted to the West Peninsular region. Intensive collecting and observation in

the near future will almost certainly increase the number of endemics known from the East Peninsular, Deccan, and Ganges regions, but it is unlikely that the numbers will ever approach that in the West Peninsular area.

Beyond the changes in overlap between Indian regions, additional collecting and reporting will clarify the ranges of many species that have obviously imperfectly known distributions. As examples, we need only cite the ranges of *Uperodon systoma*, *Rana beddomii*, *R. crassa*, *R. malabarica*, and *R. syhadrensis* (see Table 1) each of which has a gap that appears to be an artifact resulting from imperfect knowledge rather than a significant biological phenomenon.

Despite the present weaknesses in the faunal lists of large areas and in the known ranges of individual species, it is clear that Indian amphibian species constitute three distributional types: (1) species confined to the Western Ghats, the largest unit; (2) species known in India only from the Northeast; and (3) a set of essentially ubiquitous species that comprise the bulk of the known fauna in all of the territory between the Western Ghats and the Northeast.

COMPARISON WITH FAUNAS OF OTHER REGIONS

Although the Indian amphibian fauna has a number of endemic genera and many endemic species, it does share species with adjacent areas (see above). Most of these shared species occur in Burma (33 anurans, 1 salamander) and somewhat fewer in Sri Lanka (21 species of anurans) and Nepal (16 anurans, 1 salamander). These relations are what one would expect given the relative sizes of the adjacent faunas and the nature of environments at the borders. Twenty-one species are shared with China, but all except

5 of them also are known from Burma. None of the Indian caecilians is known from outside the country.

Compared to anuran faunas to the east, the Indian fauna seems to have high proportions of frogs of the families Ranidae and Rhacophoridae and low proportions of Pelobatidae and Microhylidae (Table 3). However, apply-

Diversity of the Indian anuran fauna at the species level appears to be higher than in the other Asian faunas (Table 3). The difference may be due to the wide geographic separation of the two largest Indian subregional faunas, which has clearly resulted in two separate areas of speciation, and the juxtaposition of one of them to a rich,

TABLE 3

COMPARISON OF INDIAN AMPHIBIAN FAUNA WITH THOSE OF OTHER ORIENTAL AREAS. SOURCES FOR AREAS OTHER THAN INDIA

Family	India			Thailand			Yunnan			Borneo		
	Number of gen.*	% of spp.**	% of spp.	Number of gen.	% of spp.	% of spp.	Number of gen.	% of spp.	% of spp.	Number of gen.	% of spp.	% of spp.
ANURA	27	165		22	86		18	60		26	122	
DISCOGLOSSIDAE							1	2	3.3	1	1	0.8
PELOBATIDAE	3	6	3.6	2	11	12.8	3	11	18.3	3	11	9.0
HYLIDAE	1	1	0.6	1	1	1.2	1	1	1.7			
BUFONIDAE	4	21	12.7	4	7	8.1	1	2	3.3	6	28	23.0
MICROHYLIDAE	5	15	9.1	5	13	15.1	4	9	15.0	7	20	16.4
RANIDAE	8	77	46.7	4	37	43.0	4	23	38.3	5	34	27.9
RHACOPHORIDAE	6	45	27.3	6	17	19.8	4	12	20.0	4	28	23.0
GYMNOPHIONA	4	15		1	4		1	1		2	5	
CAECILIIDAE	2	4										
ICHTHYOPHIIDAE	2	11		1	4		1	1		2	5	

Sources: Anura=Thailand—Taylor, 1962. Yunnan—Zool. Inst. Sichuan, 1977. Borneo—Inger, 1966; Inger & Frognier, 1979; Inger & Gritis, 1983; Dring, 1983a & b; Kiew, 1984a, 1984b; Matsui, 1986. Gymnophiona=Frost, 1985.

* Genera.

** Species.

ing an arcsin test of the proportion of species in each family in the Indian fauna against the corresponding proportion in each of the other faunas yields only one statistically significant difference: that between the proportions of ranid species in the Indian and Bornean faunas ($t=3.40$, $P=0.001$). Therefore, in terms of distribution of species of anurans in families, the Indian fauna does not differ importantly from the Southeastern faunas.

external source (Burma) of additional species. Diversity of Indian anurans in terms of genera does not differ significantly from the other Asian faunas (Table 3).

India clearly has a larger and generically more diverse caecilian fauna than the other areas (Table 3). As observed earlier, this high diversity is concentrated almost entirely in the Western Ghats.

CONCLUSION

The following points seem evident to us:

- (1) That the Indian amphibian fauna as a whole is quite distinct, having endemic genera of ranid and microhylid frogs and caecilians, and a large number of endemic species of several wide-spread Oriental genera — *Bufo*, *Rana*, *Philautus*, and *Ichthyophis*.
- (2) That there are only two Indian areas of known high endemism, the Northeast and the West Peninsular (which includes the Western Ghats).
- (3) That the Indian fauna is divisible into three groups of species: those known only

from the Northeast, those known only from the Western Ghats, and a small group of ubiquitous species.

- (4) That as expected the regions abutting other continental areas, that is, the Northwest and Northeast, show the highest levels of non-Indian species.
- (5) That the actual geographic distributions of many Indian species are very poorly known and, therefore, that knowledge of the faunas of several Indian regions is very weak.
- (6) That additional intensive collecting and observation will certainly result in the discovery of new species as well as improvement in our understanding of distribution of the fauna.

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